

Leica HDS Check & Adjust – User Manual

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1 Overview

Leica Geosystems 3D laser scanners are manufactured, assembled and adjusted to the best possible quality. Nevertheless, extreme temperature changes and hard shocks can cause deviations and influence the system accuracy. 3D laser scanners that are exposed to such hard conditions should be checked periodically to ensure that the measurement results meet the specifications. This can be done in the field by running through specific measurement procedures. The deviations determined by the Check & Adjust procedures can be stored permanently and applied as corrections to every scan automatically.

2 Access to Check & Adjust Menu

Select **Main Menu: Tools... \ Check & Adjust...**

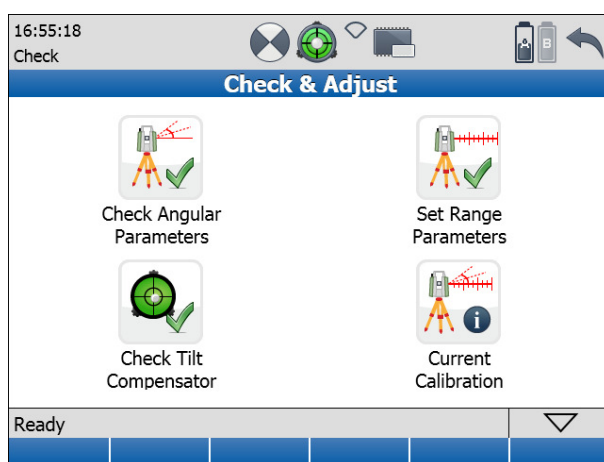






Figure 1: Check & Adjust Menu

The Check & Adjust menu provides four functions:

Function	Description	Refer to section
 Check Angular Parameters	The angular system parameters can be determined by means of a field procedure and registered in the instrument. The following deviations can be checked and adjusted: $\lambda 1, \lambda 2$ Laser alignment deviations μ Deviation of the line of sight ϵ Deviation of the tilting axis Δel Deviation of the vertical index	3
 Set Range Parameters	In case the distance measuring unit has been checked by means of a standard procedure on a reference baseline, the range offset parameter can be registered in the instrument.	4
 Check Tilt Compensator	The tilt sensor can be checked and its parameters can be updated by an easy-to-use tilt sensor check. The following deviations can be checked and adjusted: L, T Compensator longitudinal and transversal index error	5

Function	Description	Refer to section
 Current Calibration	The currently stored corrections determined in Check & Adjust are displayed and can be reset to the factory-default values.	6

3 Check Angular Parameters

The angular system parameters are checked in a guided field procedure.

In this field procedure the instrument has to be set up on two different stations. From both stations at least five Black&White targets will be scanned in both faces.

After collecting all measurement data the software will automatically check the target scans and evaluate the measurement data. Finally the determined angular deviations will be displayed and can be registered in the instrument as corrections.

In order to ensure a thorough parameter check the measurement configuration has to fulfill certain configuration criteria.

3.1 Measurement Configuration

The measurement configuration of the angular parameter check has to meet six criteria:

1. No target must be scanned in a distance shorter than 2.5 m.
2. There has to be at least one target behind and close to each station near horizon, i.e.:
 - Next to each station a target has to be positioned in a minimal distance of 2.5 m and in a maximum distance of $ds/3$, where ds is the distance between both stations.
 - These targets have to be positioned within a maximum angle of 15° above or beneath the horizontal plane.
 - These targets have to be positioned in a horizontal direction of 135° up to 225° relative to the direction to the farer station.
3. There has to be at least one target in a distance of at least ds from both stations, where ds is the distance between both stations. It has to be positioned in a maximum angle of 5° above or beneath the horizontal plane.
4. There has to be at least one target in a height of at least 18 m above one station in a minimum angle of 73° above the horizontal plane.
5. The distance between both stations ds has to be equal or greater than 20 m.
6. At least five targets in five different positions are necessary.

Figure 2 visualizes the measurement configuration criteria 2 to 6.

In case all six configuration criteria are met all angular deviations can be checked by evaluating the target scans.

In case one or more criteria are not met only a subset of the angular deviations will be considered and checked.

- ☞ Always consider the laser beam's angle of incidence on the target plane when positioning the targets and defining the station positions!
The angle of incidence should never be less than 60° , while 90° is the optimum angle.
- ☞ The minimum number of targets is five. Nevertheless it is recommended to use six to eight targets for the check.

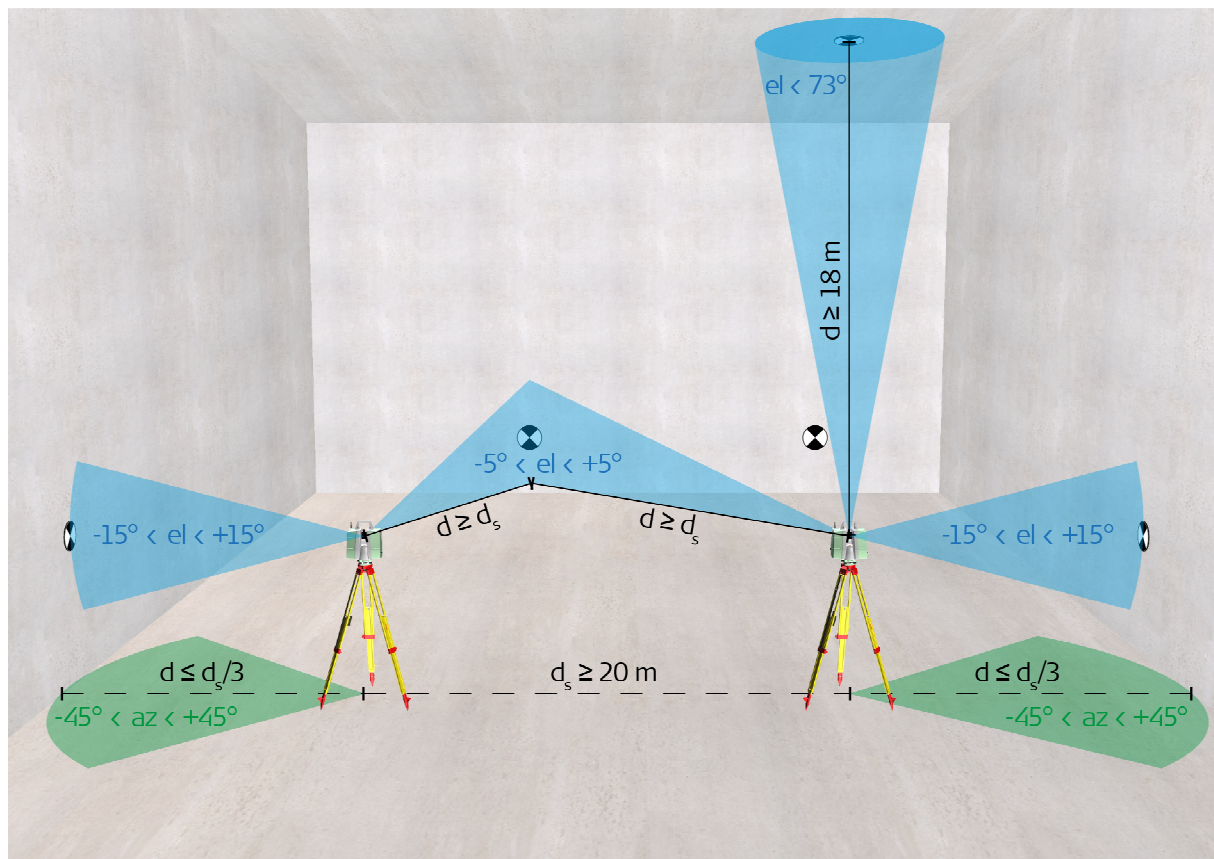



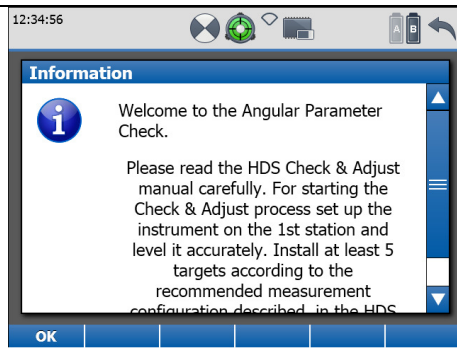

Figure 2: Measurement configuration criteria for a complete angular parameter check

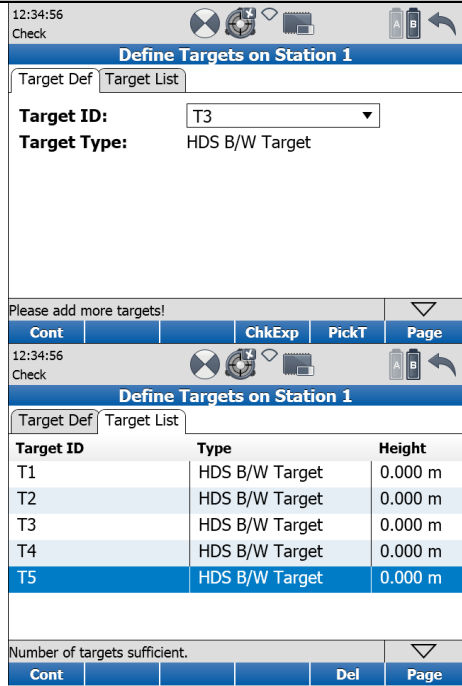







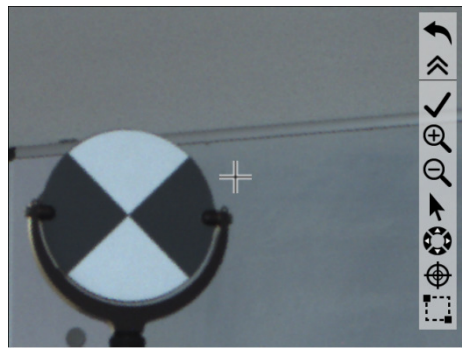

3.2 Basic Workflow

The angular parameter check is a guided procedure. The basic steps are:

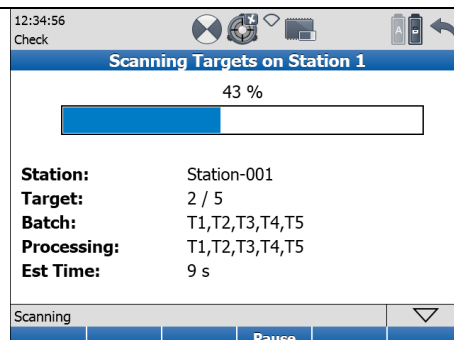
1. Setting up at least five targets.
2. Setting up the instrument on station 1.
3. Defining the target scans and scanning the targets.
4. Reviewing the scans.
5. Setting up the instrument on station 2.
6. Defining at least two target scans out of the five targets used on station 1 and scanning these targets.
7. Reviewing the scans.
8. Automatically scanning the remaining targets.
9. Reviewing the scans.
10. Automatic evaluation and calculation of the results.
11. Registering or skipping the results.

3.3 Detailed Workflow

Step	Description
	<ul style="list-style-type: none"> Before starting the measurements the instrument has to become acclimatised to the ambient temperature. Approximately two minutes per 1°C temperature difference from storage place to working environment but at least 15 min should be taken into account. The instrument should be protected from direct sunlight in order to avoid thermal warming in general and especially on one side of the instrument housing. It is also recommended to avoid strong heat shimmer and air turbulences. The best conditions can be found usually in the morning and with overcast sky. The tribrach, the tripod and the underground should be very stable and secure from vibrations or other disturbances.
1	Define a measurement configuration according to the configuration criteria described in section 3.1.
2	Set up the instrument on station 1. <ul style="list-style-type: none"> Remove the handle from the top of the instrument in order to get a clear line of sight to targets in higher elevation angles!
3	Set up the targets in at least five different positions (cf. configuration criteria in section 3.1).
4	Tools / Check & Adjust Menu Select the option Check Angular Parameters .
5	Read the "Welcome..." message carefully. Click OK to continue.
	
6	In case the instrument has not been levelled up in a range of +/- 20 arcsec, the electronic level will be displayed. Level up the instrument in a range of +/- 20 arcsec. After levelling the instrument press Cont to continue.
	

Step	Description	
7	<p>Define the target scans on station 1. Each target scan has to be defined by...</p> <ol style="list-style-type: none"> ... specifying a target ID in the Target ID input field and... ... aiming at the target in the live video (PickT, see step 8). <p>Click ChkExp to adjust the exposure time of the live video.</p> <p>Click PickT to aim at the target in the live video (see step 8).</p> <p>Click Page or Target List to access the list of the already defined target scans. Return to the Target Definition interface by clicking Page or Target Def.</p> <p>Select a target in the list of target scans and press Del in order to remove the target scan.</p> <p>After defining one or more target scans, click Cont to start scanning the defined targets.</p>	
8	<p>Navigate in the live video by using the following functions:</p> <ul style="list-style-type: none"> Enable the rotation wheel by clicking . The rotation wheel appears in the center of the screen. It provides arrow buttons for navigating up (▲), down (▼), to the left (◀) or to the right (▶). After activating an arrow button the instrument or the mirror respectively will move in the appropriate direction continuously. The movement can be stopped by clicking anywhere on the screen. Enable the seek mode by clicking . The camera will point to any position clicked before. Use  (zoom-in) or  (zoom-out). <p>For picking the target there are three possibilities:</p> <ul style="list-style-type: none"> Point at the target by the crosshair, e.g. by using the seek mode. Activate the pick mode by clicking  as soon as the target is in the field of view of the camera and click roughly on the target center. Activate the fence mode by clicking  and draw a fence around the target. The target will now roughly be scanned and the scan will be displayed in the target scan viewer. Activate the pick mode by clicking  and roughly click on the target center in the scan. <p>In order to confirm the picked direction to the</p>	<p>Live video:</p>  <p>Scan viewer:</p> 

Step	Description
	<p>target and to return to the Target Definition interface click ✓.</p> <p>For leaving the live video without picking a target click ↶.</p>
9	<p>Scanning the defined targets and determining their target centers is a fully automated process.</p> <p>Target scanning can be paused by clicking Pause and resumed by clicking Resume (button toggles).</p> <ul style="list-style-type: none"> Do not touch the instrument before the Target Results on Station 1 are displayed on the screen! Touching the instrument before might influence the tilt sensor measurements and can significantly influence the accuracy of the check! For every target a coarse scan is performed first. Then it is scanned in face I and in face II. In case a target scan in at least one face fails or the deviation of the target centers of face I and face II is too high, this target scan is repeated automatically in both faces. In rare cases a target scan may be performed up to three times. In case a target in a significant height above the instrument is detected, this target scan is repeated automatically. The additional target scan will be listed with suffix "_2" afterwards.
10	<p>After all defined targets were scanned the results are listed.</p> <p>If a target scan has status OK, its target center has been successfully determined in both faces. If a target scan has status Bad, even after three scanning attempts the target center could not be determined for at least one face.</p> <ul style="list-style-type: none"> If a target scan got status Bad, use the Add button to return to the Target Definition interface (see step 7). Redefine this target scan and press Cont to start the redefined target scan. <p>Click Add to return to Target Definition and add more target scans (see step 7).</p> <p>In case more than five targets have been defined a target scan can be selected in the list and can be deleted by pressing Del.</p> <p>Click View to review the selected target scan and the determined target center (see step 11).</p>



Target Results on Station 1		
Target ID	Target Type	State
T1	HDS B/W Target	OK
T1_2	HDS B/W Target	OK
T2	HDS B/W Target	Bad
T3	HDS B/W Target	Bad
T4	HDS B/W Target	OK
T5	HDS B/W Target	OK














Please add more targets!

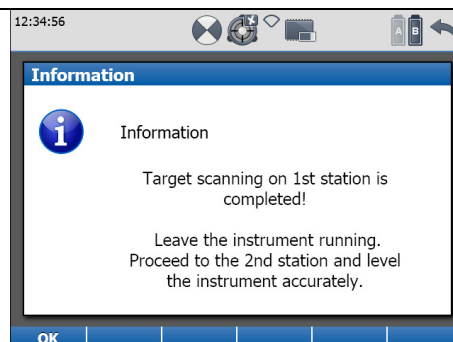
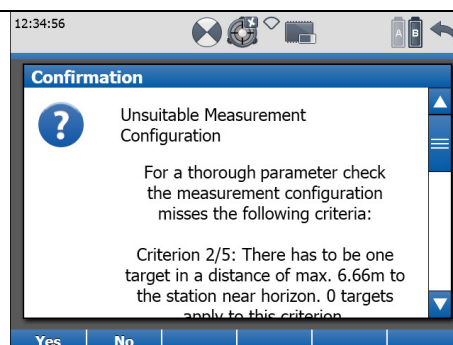
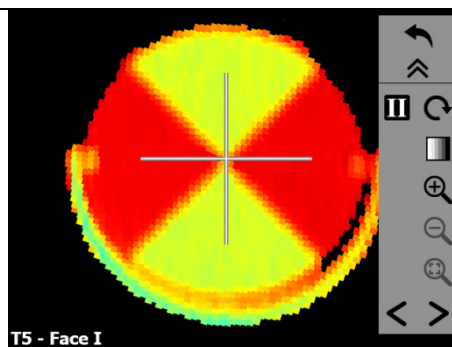
Cont Add Del View


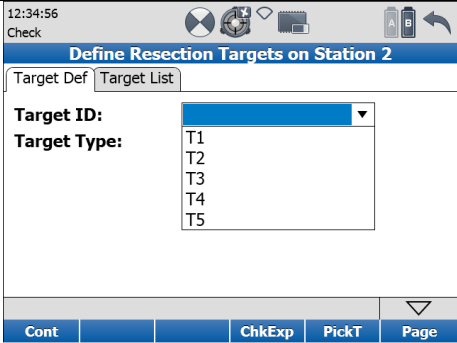
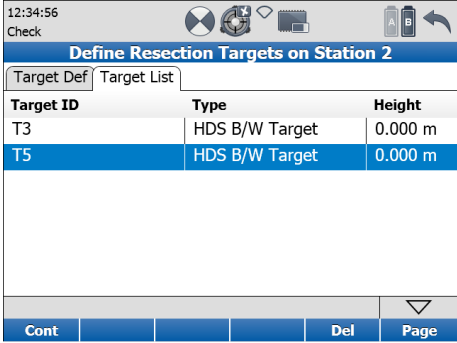
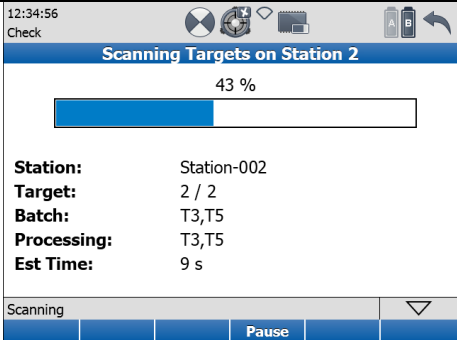
Target Results on Station 1		
Target ID	Target Type	State
T1	HDS B/W Target	OK
T1_2	HDS B/W Target	OK
T2	HDS B/W Target	OK
T3	HDS B/W Target	OK
T4	HDS B/W Target	OK
T5	HDS B/W Target	OK

Valid measurement configuration

Cont Add Del View

Step	Description
	Click Cont to finish target scanning on station 1.
11	<p>After clicking View the target scan is displayed in the target viewer. The determined target center is indicated by a vertex.</p> <p>Click / to toggle the target scans of both faces.</p> <p>Click  to rotate the target scan.</p> <p>Click / to toggle the colors of the displayed target scan.</p> <p>Use ,  or  (fit to screen) to change the scale of the target scan display.</p> <p>Browse all target scans of the list by clicking  (previous scan) and  (next scan).</p> <p>Leave the target viewer and return to the Target Results on Station 1 by clicking .</p>
12	<p>After target scanning on station 1 is finished, the measurement configuration will be checked. In case one or more configuration criteria are not met (cf. section 3.1), a message will be displayed accordingly, asking if the measurement configuration can be improved by adding more targets.</p> <p>Click Yes to return to Target Results on Station 1 and then click Add to add target scans to the measurement configuration.</p> <p>Click No to finish the check. The software will now start to evaluate the existent measurements and check as many parameters as possible (see step 21).</p>
13	<p>In case of a suitable measurement configuration on station 1, the measurement can be continued on station 2.</p> <p> Do not turn off the instrument!</p> <p>Set-up the instrument on station 2 and level it accurately.</p> <p> Remove the handle from the top of the instrument in order to get a clear line of sight to targets in higher elevation angles!</p> <p>Click OK to continue.</p>



Step	Description										
14	<p>In case the instrument has not been levelled up in a range of +/- 20 arcsec, the electronic level will be displayed.</p> <p>Level up the instrument in a range of +/- 20 arcsec.</p> <p>After levelling the instrument press Cont to continue.</p>										
15	<p>On station 2 only two of all used targets have to be defined. The results of these target scans will be used for calculating a first resection and then automatically scan the remaining targets.</p> <p>Select the appropriate target IDs from the list in the Target ID field and press PickT to aim at the targets in the live video (For target picking instructions please see step 8).</p> <p>☞ For this purpose it is not recommended to select a target which is positioned in a high elevation!</p> <p>Click ChkExp to adjust the exposure time of the live video.</p> <p>Click PickT to aim at the target in the live video (see step 8).</p> <p>Click Page or Target List to access the list of the already defined target scans. Return to the Target Definition interface by clicking Page or Target Def.</p> <p>Select a target in the list of target scans and press Del in order to remove the target scan.</p> <p>Define at least two target scans and click Cont to start the scans.</p>	  <table border="1"> <thead> <tr> <th>Target ID</th><th>Type</th><th>Height</th></tr> </thead> <tbody> <tr> <td>T3</td><td>HDS B/W Target</td><td>0.000 m</td></tr> <tr> <td>T5</td><td>HDS B/W Target</td><td>0.000 m</td></tr> </tbody> </table>	Target ID	Type	Height	T3	HDS B/W Target	0.000 m	T5	HDS B/W Target	0.000 m
Target ID	Type	Height									
T3	HDS B/W Target	0.000 m									
T5	HDS B/W Target	0.000 m									
16	<p>The defined target scans are performed.</p> <p>Target scanning can be paused by clicking Pause and resumed by clicking Resume (button toggles).</p> <p>☞ Do not touch the instrument before the Resection Results are displayed on the screen! Touching the instrument before might influence the tilt sensor measurements and can significantly influence the accuracy of the check!</p>										

Step	Description
	<p>☞ For every target a coarse scan is performed first. Then it is scanned in face I and in face II.</p>
17	<p>After the defined targets were scanned the Re-section Results are displayed.</p> <p>If no resection result is available, one or more target scans might have failed. Therefore check the target scans by selecting Target List (or clicking Page twice).</p> <p>If a target scan has initially the Use flag Yes in the Target List, its target center has been successfully determined in both faces and its result will be used for the resection calculation.</p> <p>If a target scan has initially the Use flag No, the target center could not be determined in at least one face.</p> <p>☞ If a target scan got the Use flag No, use the Add button to return to Define Resection Targets on Station 2 (see step 15). Redefine the same target scan or define another target scan and press Cont to start the scan.</p> <p>Click View to review the selected target scan and the determined target center.</p> <p>Click More to review the residuals of the target centers. If the residuals in column dE/dN/dH are not greater than 15 mm, the resection result is acceptable for proceeding with the check.</p> <p>Click Add to return to Define Resection Targets on Station 2 and add more target scans (see step 15), e.g. for improving the resection results.</p> <p>If the residuals in column dE/dN/dH are equal or below 15 mm, click Cont to start scanning the remaining targets on station 2.</p>

12:34:56
Check

Resection Results

Stn Coords Sigma Target List Plot

Station ID: Station-002
Instrument Ht: 0.000 m
No of Targets: 2
Northing: 17.123 m
Easting: 10.345 m
Height: 0.234 m

Ready

Set Page

12:34:56
Check

Resection Results

Stn Coords Sigma Target List Plot

Station ID: Station-002
σNorthing: 0.001 m
σEasting: 0.000 m
σHeight: 0.002 m
σHz Orient: 3"

Ready

Cont Page

12:34:56
Check

Resection Results

Stn Coords Sigma Target List Plot

Target ID	dE	Use
T3	0.000	Yes
T5	-0.002	Yes

Ready

Cont Add View More Page

12:34:56
Check

Resection Results

Stn Coords Sigma Target List Plot

Ready

Cont Page

Step	Description																						
18	<p>The remaining targets are scanned automatically.</p> <ul style="list-style-type: none">Do not touch the instrument before the Target Results on Station 2 are displayed on the screen! Touching the instrument before might influence the tilt sensor measurements and can significantly influence the accuracy of the check!Every target is scanned in face I and in face II.In case a target scan in at least one face fails or the deviation of the target centers of face I and face II is too high, this target scan is repeated automatically in both faces. In rare cases a target scan may be performed up to three times.Targets already scanned for the resection might be repeated automatically in this step if their deviation of the target centers in face I and face II was too high.	<div><div>12:34:56 Check</div><div>Scanning Targets on Station 2</div><div>43 %</div><div><div></div></div><div>Station: Station-002 Target: 2 / 4 Batch: T1,T1_2,T2,T4 Processing: T1,T1_2,T2,T4 Est Time: 9 s</div><div>Scanning<div>Pause</div></div></div>																					
19	<p>After the remaining targets were scanned the results are listed.</p> <p>If a target scan has status OK, its target center has been successfully determined in both faces. If a target scan has status Bad, even after three scanning attempts the target center could not be determined for at least one face. This target scan will be excluded from the upcoming evaluation.</p> <p>Click View to review the selected target scan and the determined target center.</p> <p>Click Cont to start the evaluation.</p>	<div><div>12:34:56 Check</div><div>Target Results on Station 2</div><table><tr><th>Target ID</th><th>Target Type</th><th>State</th></tr><tr><td>T1</td><td>HDS B/W Target</td><td>OK</td></tr><tr><td>T1_2</td><td>HDS B/W Target</td><td>OK</td></tr><tr><td>T2</td><td>HDS B/W Target</td><td>OK</td></tr><tr><td>T3</td><td>HDS B/W Target</td><td>OK</td></tr><tr><td>T4</td><td>HDS B/W Target</td><td>OK</td></tr><tr><td>T5</td><td>HDS B/W Target</td><td>OK</td></tr></table><div>Configuration allows complete parameter check.</div><div>ContView</div></div>	Target ID	Target Type	State	T1	HDS B/W Target	OK	T1_2	HDS B/W Target	OK	T2	HDS B/W Target	OK	T3	HDS B/W Target	OK	T4	HDS B/W Target	OK	T5	HDS B/W Target	OK
Target ID	Target Type	State																					
T1	HDS B/W Target	OK																					
T1_2	HDS B/W Target	OK																					
T2	HDS B/W Target	OK																					
T3	HDS B/W Target	OK																					
T4	HDS B/W Target	OK																					
T5	HDS B/W Target	OK																					
20	<p>In the automatic evaluation process the overall measurement configuration is checked and the angular deviations are determined. In case one or more configuration criteria are not met (cf. section 3.1) or the required measurement accuracy cannot be achieved, an appropriate message is displayed on the screen.</p> <p>In case a message is displayed, read it carefully and click OK.</p>	<div><div>12:34:56 Check</div><div>Calculating Check & Adjust Parameters</div><div>43 %</div><div><div></div></div><div></div></div>																					
21	<p>After the evaluation, the determined angular deviations are displayed.</p> <p>In case the configuration criteria are met five angular deviations will be determined and displayed.</p> <p>In case one or more configuration criteria are not met only a subset of the angular deviations will be determined and displayed.</p>	<div><div>12:34:56 Check</div><div>Angular Check & Adjust Results</div><table><tr><th>Parameter</th><th>Result</th></tr><tr><td>λ_1</td><td>8"</td></tr><tr><td>λ_2</td><td>9"</td></tr><tr><td>μ</td><td>-3"</td></tr><tr><td>ϵ</td><td>2"</td></tr><tr><td>Δ_{el}</td><td>-3"</td></tr></table><div>Ready</div><div>ContSet</div></div>	Parameter	Result	λ_1	8"	λ_2	9"	μ	-3"	ϵ	2"	Δ_{el}	-3"									
Parameter	Result																						
λ_1	8"																						
λ_2	9"																						
μ	-3"																						
ϵ	2"																						
Δ_{el}	-3"																						

Step	Description
	Click Set to register the determined deviations permanently. All future scans will automatically be corrected by these values.
	Click Cont to skip the check results and retain the current calibration.

For each performed angular parameter check a project is automatically created. The project name is composed of the prefix "CnA_" and a time stamp, e.g. "CnA_20121221_1045". This project contains the target scan data acquired during the check.

Additionally each performed angular parameter check is logged in an extra log file. This log file can be downloaded by connecting a USB drive to the instrument and selecting **Main Menu: Tools...\Transfer...\Logs**.

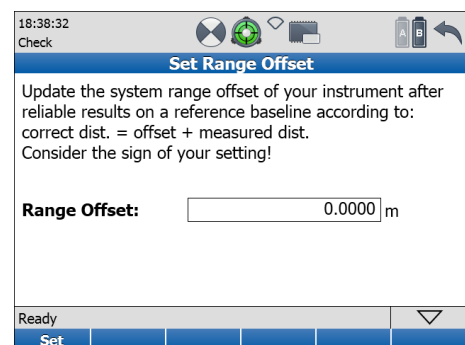
On the USB drive the log file of the check is saved in the directory "Log".

The name of the log file is composed of the prefix "check_n_adjust_report_..." and a time stamp, e.g. "check_n_adjust_report_20121221_1045.txt".

4 Set Range Parameters

After checking the instrument's distance measuring unit on a distance reference baseline and determining a significant range offset, this range offset can be permanently registered. All future scans will automatically be corrected by use of this range offset.

Access the **Set Range Offset** interface by selecting **Main Menu: Tools...\Check & Adjust...\Set Range Parameters**.


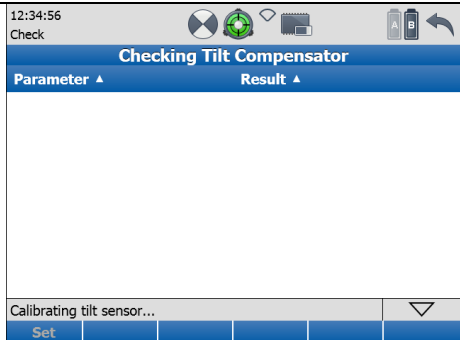

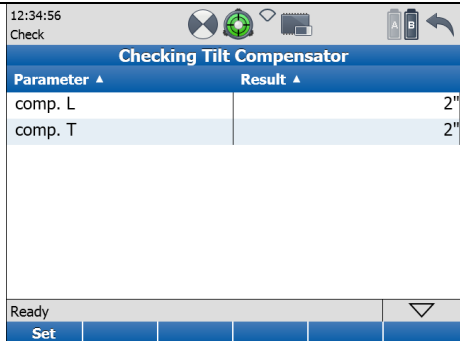


The specified range offset will be applied to all future scanning data by

corrected distance = measured distance + range offset

5 Check Tilt Compensator

The check of the tilt compensator is a fully-automated process.

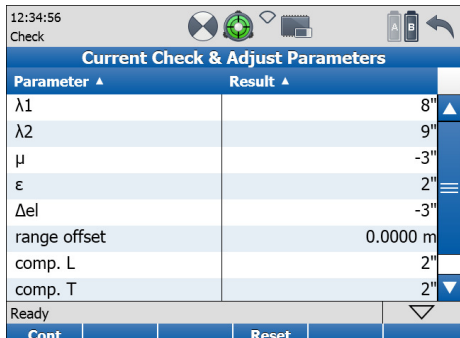
Step	Description
	<ul style="list-style-type: none"> Before starting the measurements the instrument has to become acclimatised to the ambient temperature. Approximately two minutes per 1°C temperature difference from storage place to working environment but at least 15 min should be taken into account. The instrument should be protected from direct sunlight in order to avoid thermal warming in general and especially on one side of the instrument housing. It is also recommended to avoid strong heat shimmer and air turbulences. The best conditions can be found usually in the morning and with overcast sky. The instrument should be set up on solid ground.
1.	Level up the instrument.
2.	Tools / Check & Adjust Menu Select the option Check Tilt Compensator .
3.	The instrument is turning horizontally and stopping in several positions. <ul style="list-style-type: none"> Do not touch the instrument as long as the check is ongoing and no results are displayed on the screen.
	
4.	After the check is finished the results of the tilt compensator check are listed on the screen. <p>Click Set to register the determined deviations permanently. All further tilt measurements will automatically be corrected by these values.</p> <p>To skip the check results and retain the current calibration click .</p>
	

6 Current Calibration

In the **Current Calibration** list the parameters determined in a check and stored permanently in the instrument can be reviewed.

Click **Reset** to reset all user-determined parameters and restore the in-factory calibration.

Click **Cont** to return to the **Main Menu**.



Parameter	Result
λ1	8"
λ2	9"
μ	-3"
ε	2"
Δel	-3"
range offset	0.0000 m
comp. L	2"
comp. T	2"
Ready	
Cont	Reset